USGS
science for a changing world

Fish Lesions and Fish Kills: The Role of USGS

Figure 1. Fish lesions.

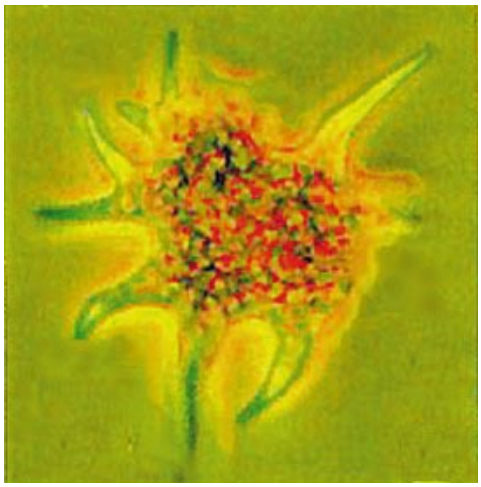

Figure 2. Amoeboid to cysted stage.

The Problem

The incidence of fish health problems, ranging from small external sores and lesions to large-scale fish-kills, is a growing problem in the Chesapeake Bay and other mid-Atlantic estuaries from Delaware Bay to North Carolina. Fish kills have been reported in North Carolina since the early 1990's and have become increasingly apparent in the Chesapeake Bay over the past year. Human health problems associated with dead and diseased fish have occurred in both areas, resulting in health warnings and closings of rivers to commercial fishing and recreational activities. The fish kills and lesions, and human health effects may signal ecosystem-wide problems and potential human and ecological impacts.

Fish Lesions and *Pfiesteria*

Lesions observed in menhaden, striped bass and other fish from the Chesapeake Bay range from pinpoint sores to large, deep penetrating wounds (fig.1). These lesions contain several types of bacteria, fungi, and protozoans. Chief among suspected causes of the more serious lesions and death in fish is the recently discovered one-celled microorganism, *Pfiesteria piscicida*. In the presence of fish, *Pfiesteria* transforms from encysted or amoeboid life stages in estuarine sediments to a highly toxic flagellated form in the water column (fig.2). This flagellated form secretes powerful toxins that dissolve mucous and skin tissues and a neurotoxin that causes respiratory distress and death in fish.

Pfiesteria or *Pfiesteria*-like dinoflagellate blooms are believed to have caused fish kills in the Chesapeake Bay, North Carolina, laboratories, and an aquaculture operation. The life history of this organism is complex and much remains unknown about its ecology. In laboratory studies, the dinoflagellate is toxic over broad salinity and temperature ranges, with optimal growth conditions at temperatures of 26° C or greater and salinities of 15 parts per thousand. *Pfiesteria* is stimulated to transform in lab cultures by elevated phosphate levels. Fish kills in Maryland rivers seem to be associated with nutrient enrichment, warm temperatures, high salinities, and storm events.

USGS Involvement in the Chesapeake Bay

In 1983, the Environmental Protection Agency began the Chesapeake Bay Program with other Federal agencies and States to restore ecosystems in the Bay. The USGS has been an active partner since the formation of this program and has provided scientific information on the relationship between nutrient inputs in the watershed, and improvements in water quality and selected living resources in the Bay.

In 1996, the USGS Chesapeake Bay Ecosystem Program was initiated to focus energies of the four USGS Divisions on collection and interpretation of scientific information to help resource managers determine the success of management strategies and the response of the Bay's ecosystems to nutrient reduction.

Detailed investigations are designed to clarify principle factors affecting nutrient and sediment transport and their relation to the changes in the sources of these constituents in selected hydrogeomorphic regions (HGMR's) of the watershed

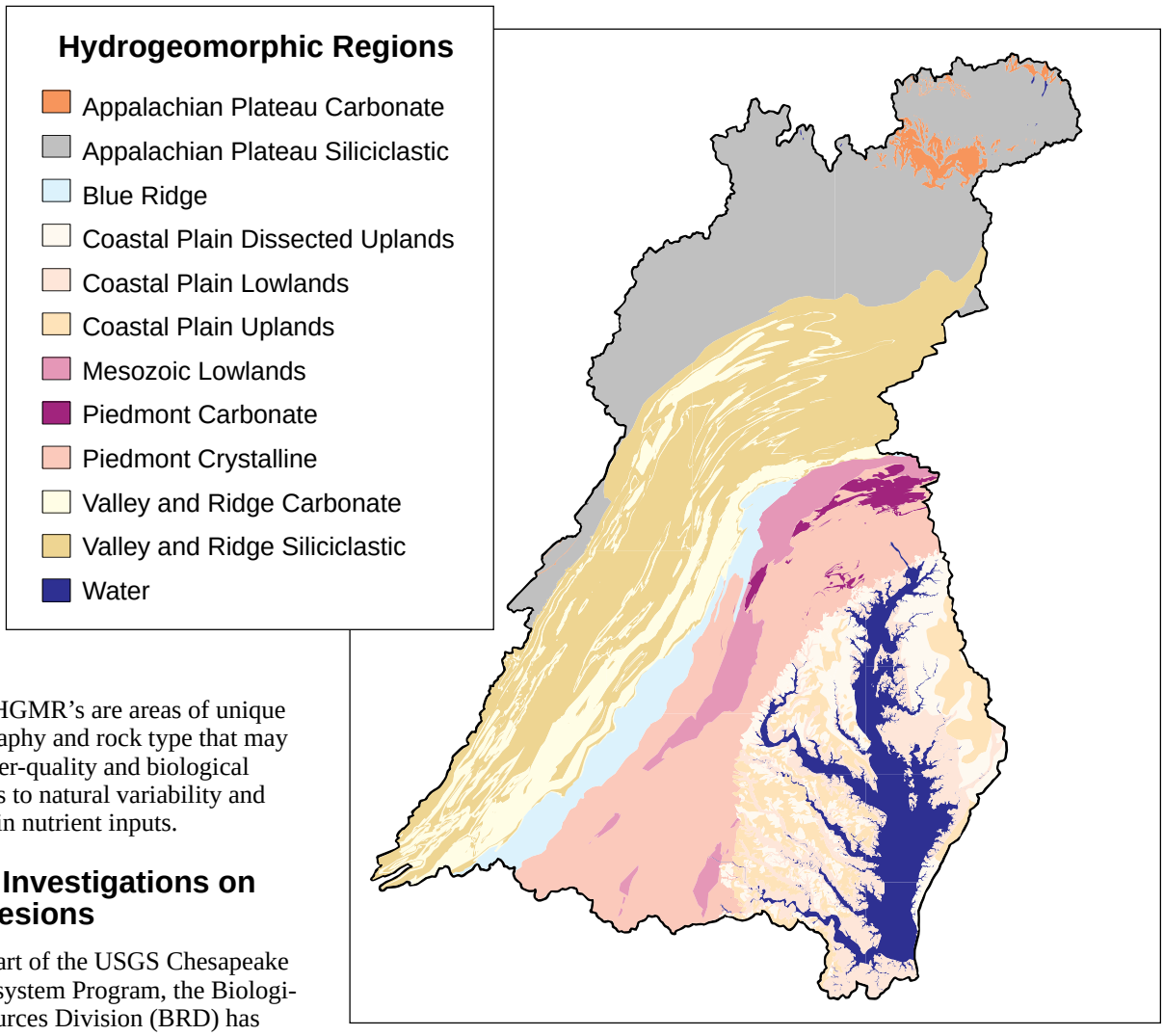

Figure 3. Chesapeake Bay basin with major hydrogeomorphic regions.

(fig. 3). HGMR's are areas of unique physiography and rock type that may have water-quality and biological responses to natural variability and changes in nutrient inputs.

USGS Investigations on Fish Lesions

As part of the USGS Chesapeake Bay Ecosystem Program, the Biological Resources Division (BRD) has begun investigations to determine factors contributing to fish lesions in selected tributaries of the Chesapeake Bay. This work includes rivers where lesions have been found as well as apparently unaffected streams and complements the efforts of Maryland state agencies focused on the Pocomoke River and nearby tributaries. BRD's particular expertise in fish health diagnosis and GIS analysis will be used to:

- Characterize the types and causes of fish lesions;
- Evaluate fish health with a variety of physiological, histological, and immunological techniques;
- Describe and document the areal extent and seasonal occurrence of fish lesions and sores; and
- Assess possible linkages of fish health problems to land use, land use history, and water quality.

The investigations include field sampling and experiments, laboratory analyses, and compilation and analyses of data in a GIS data base. The work will be done in collaboration with partners in various agencies of the State of Maryland as well as other Federal agencies.

The Opportunity

As the primary science agency in the Department of the Interior, the USGS is uniquely qualified to provide scientific information and analyses on regional and national scales. Additional investigations are needed to determine how a watershed's nutrient sources and physical characteristics relate to nutrient delivery, algal blooms, and fish health in an estuary. With additional funding, future opportunities for the USGS to assist others may include:

- Expanded sampling and experiments to assess fish health and increased GIS coverage for a larger areal extent of the region;
- Providing high resolution land use/land cover data for regional and national data bases;
- Characterization of primary nutrient delivery pathways to tidal tributaries through ground and surface water;
- Construction of predictive tools to estimate nutrient sources, loads, and delivery; and
- Exploratory investigations to determine the distribution of dinoflagellate cysts in estuarine sediments.

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